CONCRETE BLOCK MOLD WITH MOVEABLE LINER

The Field of the Invention

The present invention relates to concrete block molds, and more particularly to a concrete block mold adapted for use with a concrete block machine and having at least one moveable liner.

Background of the Invention

Concrete blocks, also referred to as concrete masonry units (CMU's), are typically manufactured by forming them into various shapes using a concrete block machine employing a mold frame assembled so as to form a mold box. A mold cavity having a negative of a desired shape of the block to be formed is provided within the mold box. A support board, or pallet, is moved via a conveyor system onto a pallet table. The pallet table is moved upward until the pallet contacts and forms a bottom of the mold box. The cavity is then filled with concrete by a moveable feedbox drawer.

As soon as the mold is filled with concrete, the feedbox drawer is moved back to a storage position and a plunger, or head shoe assembly, descends to form a top of the mold. The head shoe assembly is typically matched to the top outside surface of the mold cavity and is hydraulically or mechanically pressed down on the concrete. The head shoe assembly compresses the concrete to a desired pounds-per-square-inch (psi) rating and block dimension while simultaneously vibrating the mold along with the vibrating table, resulting in substantial compression and optimal distribution of the concrete throughout the mold cavity.

Because of the compression, the concrete reaches a level of hardness that permits immediate stripping of the finished block from the mold. To remove the finished block from the mold, the mold remains stationary while the shoe and pallet table, along with the corresponding pallet, are moved downward and force the block from the mold onto the pallet. As soon as the bottom edge of the head shoe assembly clears the bottom edge of the mold, the conveyor system moves

the pallet with the finished block forward, and another pallet takes its place under the mold. The pallet table then raises the next pallet to form a bottom of the mold box for the next block, and the process is repeated.

For many types of CMU's (e.g., pavers, patio blocks, light weight blocks, cinder blocks, etc.), but for retaining wall blocks and architectural units in particular, it is desirable for at least one surface of the block to have a desired texture, such as a stone-like texture. One technique for creating a desired texture on the block surface is to provide a negative of a desired pattern or texture on the side walls of the mold. However, because of the way finished blocks are vertically ejected from the mold, any such pattern or texture would be stripped from the side walls unless they are moved away from the mold interior prior to the block being ejected.

One technique employed for moving the sidewalls of a mold involves the use of a cam mechanism to move the sidewalls of the mold inward and an opposing spring to push the sidewalls outward from the center of the mold. However, this technique applies an "active" force to the sidewall only when the sidewall is being moved inward and relies on the energy stored in the spring to move the sidewall outward. The energy stored in the spring may potentially be insufficient to retract the sidewall if the sidewall sticks to the concrete. Additionally, the cam mechanism can potentially be difficult to utilize within the limited confines of a concrete block machine.

A second technique involves using a piston to extend and retract the sidewall. However, a shaft of the piston shaft is coupled directly to the moveable sidewall and moves in-line with the direction of movement of the moveable sidewall. Thus, during compression of the concrete by the head shoe assembly, an enormous amount of pressure is exerted directly on the piston via the piston shaft. Consequently, a piston having a high psi rating is required to hold the sidewall in place during compression and vibration of the concrete. Additionally, the direct pressure on the piston shaft can potentially cause increased wear and shorten the expected life of the piston.

Summary of the Invention

One aspect of the present invention provides a mold assembly for manufacturing concrete blocks that is adapted for use in a concrete block machine. The mold assembly comprises a plurality of liner plates and a gear drive assembly. Each liner plate has a major surface and the liner plates are configured such that the major surfaces form a mold cavity, wherein at least one of the liner plates is moveable. The gear drive assembly is selectively coupled to the at least one moveable liner plate and is configured to move the at least one moveable liner plate in a first direction toward an interior of the mold cavity by applying a force in a second direction different from the first direction, and to move the liner plate in a direction away from the interior of the mold cavity by applying a force in a direction opposite the second direction.

Brief Description of the Drawings

Figure 1A is a perspective view of one exemplary embodiment of a mold assembly having moveable liner plates according to the present invention.

Figure 2 is a perspective view of one exemplary embodiment of a gear drive assembly and moveable liner plate according to the present invention.

Figure 3A is a top view of gear drive assembly and moveable liner plate as illustrated in Figure 2.

Figure 3B is a side view of gear drive assembly and moveable liner plate as illustrated in Figure 2.

Figure 4A is a top view of the mold assembly of Figure 1 having the liner plates retracted.

Figure 4B is a top view of the mold assembly of Figure 1 having the liner plates extended.

Figure 5A illustrates a top view of one exemplary embodiment of a gear plate according to the present invention.

Figure 5B illustrates an end view of the gear plate illustrated by Figure 5A.

Figure 5C illustrates a bottom view of one exemplary embodiment of a gear head according to the present invention.

Figure 5D illustrates an end view of the gear head of Figure 5C.

Figure 6A is a top view of one exemplary embodiment of a gear track according to the present invention.

Figure 6B is a side view of the gear track of Figure 6A.

Figure 6C is an end view of the gear track of Figure 6A.

Figure 7 is a diagram illustrating the relationship between a gear track and gear plate according to the present invention.

Figure 8A is a top view illustrating the relationship between one exemplary embodiment of a gear head, gear plate, and gear track according to the present invention.

Figure 8B is a side view of the illustration of Figure 8A.

Figure 8C is an end view of the illustration of Figure 8A.

Figure 9A is a top view illustrating one exemplary embodiment of a gear plate being in a retracted position within a gear track according to the present invention.

Figure 9B is a top view illustrating one exemplary embodiment of a gear plate being in an extended position from a gear track according to the present invention.

Figure 10A is a diagram illustrating one exemplary embodiment of drive unit according to the present invention.

Figure 10B is a partial top view of the drive unit of the illustration of Figure 10A.

Figure 11A is a top view illustrating one exemplary embodiment of a mold assembly according to the present invention.

Figure 11B is a diagram illustrating one exemplary embodiment of a gear drive assembly according to the present invention.

Figure 12 is a perspective view illustrating a portion of one exemplary embodiment of a mold assembly according to the present invention.

Figure 13 is a perspective view illustrating one exemplary embodiment of a gear drive assembly according to the present invention.

Description of the Preferred Embodiments

In the following Detailed Description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "top," "bottom," "front," "back," "leading," "trailing," etc., is used with reference to the orientation of the Figure(s) being described. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

Figure 1A is a perspective view of one exemplary embodiment of a mold assembly 30 having moveable liner plates 32a, 32b, 32c and 32d according to the present invention. Mold assembly 30 includes a drive system assembly 31 having side-members 34a and 34b and cross-members 36a and 36b, respectively having an inner wall 38a, 38b, 40a, and 40b, and coupled to one another such that the inner surfaces form a mold box 42. In the illustrated embodiment, cross members 36a and 36b are bolted to side members 34a and 34b with bolts 37.

Moveable liner plates 32a, 32b, 32c, and 32d, respectively have a front surface 44a, 44b, 44c, and 44d configured so as to form a mold cavity 46. In the illustrated embodiment, each liner plate has an associated gear drive assembly located internally to an adjacent mold frame member. A portion of a gear drive assembly 50 corresponding to liner plate 32a and located internally to cross-member 36a is shown extending through side-member 34a. Each gear drive assembly is selectively coupled to its associated liner plate and configured to move the liner plate toward the interior of mold cavity 46 by applying a first force in a first direction parallel to the associated cross-member, and to move the liner plate away from the interior of mold cavity 46 by applying a second force

in a direction opposite the first direction. Side members 34a and 34b and cross-members 36a and 36b each have a corresponding lubrication port that extends into the member and provides lubrication to the corresponds gear elements. For example, lubrication ports 48a and 48b. The gear drive assembly and moveable liner plates according to the present invention are discussed in greater detail below.

In operation, mold assembly 30 is selectively coupled to a concrete block machine. For ease of illustrative purposes, however, the concrete block machine is not shown in Figure 1. In one embodiment, mold assembly 30 is mounted to the concrete block machine by bolting side members 34a and 34b of drive system assembly 31 to the concrete block machine. In one embodiment, mold assembly 30 further includes a head shoe assembly 52 having dimensions substantially equal to those of mold cavity 46. Head shoe assembly 52 is also configured to selectively couple to the concrete block machine.

Liner plates 32a through 32d are first extended a desired distance toward the interior of mold box 42 to form the desired mold cavity 46. A vibrating table on which a pallet 56 is positioned is then raised (as indicated by directional arrow 58) such that pallet 56 contacts and forms a bottom to mold cavity 46. In one embodiment, a core bar assembly (not shown) is positioned within mold cavity 46 to create voids within the finished block in accordance with design requirements of a particular block.

Mold cavity 46 is then filled with concrete from a moveable feedbox drawer. Head shoe assembly 52 is then lowered (as indicated by directional arrow 54) onto mold 46 and hydraulically or mechanically presses the concrete. Head shoe assembly 52 along with the vibrating table then simultaneously vibrate mold assembly 30, resulting in a high compression of the concrete within mold cavity 46. The high level of compression fills any voids within mold cavity 46 and causes the concrete to quickly reach a level of hardness that permits immediate removal of the finished block from mold cavity 46.

The finished block is removed by first retracting liner plates 32a through 32d. Head shoe assembly 52 and the vibrating table, along with pallet 56, are then lowered (in a direction opposite to that indicated by arrow 58), while mold

assembly 30 remains stationary so that head shoe assembly 56 pushes the finished block out of mold cavity 46 onto pallet 52. When a lower edge of head shoe assembly 52 drops below a lower edge of mold assembly 30, the conveyer system moves pallet 56 carrying the finished block away and a new pallet takes its place. The above process is repeated to create additional blocks.

By retracting liner plates 32a through 32b prior to removing the finished block from mold cavity 46. liner plates 32a through 32d experience less wear and, thus, have an increased operating life expectancy. Furthermore, moveable liner plates 32a through 32d also enables a concrete block to be molded in a vertical position relative to pallet 56, in lieu of the standard horizontal position, such that head shoe assembly 52 contacts what will be a "face" of the finished concrete block. A "face" is a surface of the block that will be potentially be exposed for viewing after installation in a wall or other structure.

Figure 2 is a perspective view 70 illustrating a moveable liner plate and corresponding gear drive assembly according to the present invention, such as moveable liner plate 32a and corresponding gear drive assembly 50. For illustrative purposes, side member 34a and cross-member 36 are not shown. Gear drive assembly 50 includes a first gear element 72 selectively coupled to liner plate 32a, a second gear element 74, a single rod-end double-acting pneumatic cylinder (cylinder) 76 coupled to second gear element 74 via a piston rod 78, and a gear track 80. Cylinder 76 includes an aperture 82 for accepting a pneumatic fitting. In one embodiment, cylinder 76 comprises a hydraulic cylinder. In one embodiment, cylinder 76 comprises a double rod-end dual-acting cylinder. In one embodiment, piston rod 78 is threadably coupled to second gear element 74.

In the embodiment of Figure 2, first gear element 72 and second gear element 74 are illustrated and hereinafter referred to as a gear plate 72 and second gear element 74, respectively. However, while illustrated as a gear plate and a cylindrical gear head, first gear element 72 and second gear element 74 can be of any suitable shape and dimension.

Gear plate 72 includes a plurality of angled channels on a first major surface 84and is configured to slide in gear track 80. Gear track 80 slidably

inserts into a gear slot (not shown) extending into cross member 36a from inner wall 40a. Cylindrical gear head 74 includes a plurality of angled channels on a surface 86 adjacent to first major surface 84 of female gear plate 72, wherein the angled channels are tangential to a radius of cylindrical gear head 74 and configured to slidably mate and interlock with the angled channels of gear plate 72. Liner plate 32a includes guide posts 88a, 88b, 88c, and 88d extending from a rear surface 90. Each of the guide posts is configured to slidably insert into a corresponding guide hole (not shown) extending into cross member 36a from inner wall 40a. The gear slot and guide holes are discussed in greater detail below.

When cylinder 76 extends piston rod 78, cylindrical gear head 74 moves in a direction indicated by arrow 92 and, due to the interlocking angled channels, causes gear plate 72 and, thus, liner plate 32a to move toward the interior of mold 46 as indicated by arrow 94. It should be noted that, as illustrated, Figure 2 depicts piston rod 78 and cylindrical gear head 74 in an extended position. When cylinder 76 retracts piston rod 78, cylindrical gear head 74 moves in a direction indicated by arrow 96 causing gear plate 72 and liner plate 32 to move away from the interior of the mold as indicated by arrow 98. As liner plate 32a moves, either toward or away from the center of the mold, gear plate 72 slides in guide track 80 and guide posts 88a through 88d slide within their corresponding guide holes.

In one embodiment, a removable liner face 100 is selectively coupled to front surface 44a via fasteners 102a, 102b, 102c, and 102d extending through liner plate 32a. Removable liner face 100 is configured to provide a desired shape and/or provide a desired imprinted pattern, including text, on a block made in mold 46. In this regard, removable liner face 100 comprises a negative of the desired shape or pattern. In one embodiment, removable liner face 100 comprises a polyurethane material. In one embodiment, removable liner face 100 comprises a rubber material. In one embodiment, removable liner plate comprises a metal or metal alloy, such as steel or aluminum. In one embodiment, liner plate 32 further includes a heater mounted in a recess 104 on rear surface 90, wherein the heater aids in curing concrete within mold 46 to

reduce the occurrence of concrete sticking to front surface 44a and removable liner face 100.

Figure 3A is a top view 120 of gear drive assembly 50 and liner plate 32a, as indicated by directional arrow 106 in Figure 2. In the illustration, side members 34a and 34b, and cross member 36a are indicated dashed lines. Guide posts 88c and 88d are slidably inserted into guide holes 122c and 122d, respectively, which extend into cross member 36a from interior surface 40a. Guide holes 122a and 122b, corresponding respectively to guide posts 88a and 88b, are not shown but are located below and in-line with guide holes 122c and 122d. In one embodiment, guide hole bushings 124c and 124d are inserted into guide holes 122c and 122d, respectively, and slidably receive guide posts 88c and 88d. Guide hole bushings 124a and 124b are not shown, but are located below and in-line with guide hole bushings 124c and 124d. Gear track 80 is shown as being slidably inserted in a gear slot 126 extending through cross member 36a with gear plate 72 sliding in gear track 80. Gear plate 72 is indicated as being coupled to liner plate 32a by a plurality of fasteners 128 extending through liner plate 32a from front surface 44a.

A cylindrical gear shaft is indicated by dashed lines 134 as extending through side member 34a and into cross member 36a and intersecting, at least partially with gear slot 126. Cylindrical gear head 74, cylinder 76, and piston rod 78 are slidably inserted into gear shaft 134 with cylindrical gear head 74 being positioned over gear plate 72. The angled channels of cylindrical gear head 74 are shown as dashed lines 130 and are interlocking with the angled channels of gear plate 72 as indicated at 132.

Figure 3B is a side view 140 of gear drive assembly 50 and liner plate 32a, as indicated by directional arrow 108 in Figure 2. Liner plate 32a is indicated as being extended, at least partially, from cross member 36a. Correspondingly, guide posts 88a and 88d are indicated as partially extending from guide hole bushings 124a and 124d, respectively. In one embodiment, a pair of limit rings 142a and 142d are selectively coupled to guide posts 88a and 88, respectively, to limit an extension distance that liner plate 32a can be extended from cross member 36a toward the interior of mold cavity 46. Limit

rings 142b and 142c corresponding respectively to guide posts 88b and 88c are not shown, but are located behind and in-line with limit rings 142a and 142d. In the illustrated embodiment, the limit rings are indicated as being substantially at an end of the guide posts, thus allowing a substantially maximum extension distance from cross member 36a. However, the limit rings can be placed at other locations along the guide posts to thereby adjust the allowable extension distance.

Figure 4A and Figure 4B are top views 150 and 160, respectively, of mold assembly 30. Figure 4A illustrates liner plates 32a, 32b, 32c, and 32d in a retracted positions. Liner faces 152, 154, and 154 correspond respectively to liner plates 32b, 32c, and 32d. Figure 4B illustrates liner plates 32a, 32b, 32c, and 32d, along with their corresponding liner faces 100, 152, 154, and 156 in an extended position.

Figure 5A is a top view 170 of gear plate 72. Gear plate 72 includes a plurality of angled channels 172 running across a top surface 174 of gear plate 72. Angled channels 172 form a corresponding plurality of linear "teeth" 176 having as a surface the top surface 174. Each angled channel 172 and each tooth 176 has a respective width 178 and 180. The angled channels run at an angle (Θ) 182 from 0°, indicated at 186, across gear plate 72.

Figure 5B is an end view ("A") 185 of gear plate 72, as indicated by directional arrow 184 in Figure 5A, further illustrating the plurality of angled channels 172 and linear teeth 176. Each angled channel 172 has a depth 192.

Figure 5C illustrates a view 200 of a flat surface 202 of cylindrical gear head 76. Cylindrical gear head 76 includes a plurality of angled channels 204 running across surface 202. Angled channels 204 form a corresponding plurality of linear teeth 206. The angled channels 204 and linear teeth 206 have widths 180 and 178, respectively, such that the width of linear teeth 206 substantially matches the width of angled channels 172 and the width of angled channels 204 substantially match the width of linear teeth 176. Angled channels 204 and teeth 206 run at angle (Θ) 182 from 0°, indicated at 186, across surface 202.

Figure 5D is an end view 210 of cylindrical gear head 76, as indicated by directional arrow 208 in Figure 5C, further illustrating the plurality of angled

channels 204 and linear teeth 206. Surface 202 is a flat surface tangential to a radius of cylindrical gear head 76. Each angled channel has a depth 192 from flat surface 202.

When cylindrical gear head 76 is "turned over" and placed across surface 174 of gear plate 72, linear teeth 206 of gear head 76 mate and interlock with angled channels 172 of gear plate 72, and linear teeth 176 of gear plate 72 mate and interlock with angled channels 204 of gear head 76 (See also Figure 2). When gear head 76 is forced in direction 92, linear teeth 206 of gear head 76 push against linear teeth 176 of gear plate 72 and force gear plate 72 to move in direction 94. Conversely, when gear head 76 is forced in direction 96, linear teeth 206 of gear head 76 push against linear teeth 176 of gear plate 72 and force gear plate 72 to move in direction 98.

In order for cylindrical gear head 76 to force gear plate 72 in directions 94 and 98, angle (Θ) 182 must be greater than 0° and less than 90°. However, it is preferable that Θ 182 be at least greater than 45°. When Θ 182 is 45° or less, it takes more force for cylindrical gear head 74 moving in direction 92 to push gear plate 72 in direction 94 than it does for gear plate 72 being forced in direction 98 to push cylindrical gear head 74 in direction 96, such as when concrete in mold 46 is being compressed. The more Θ 182 is increased above 45°, the greater the force that is required in direction 98 on gear plate 72 to move cylindrical gear head 74 in direction 96. In fact, at 90° gear plate 72 would be unable to move cylindrical gear head 74 in either direction 92 or 96, regardless of how much force was applied to gear plate 72 in direction 98. In effect, angle (Θ) acts as a multiplier to a force provided to cylindrical gear head 74 by cylinder 76 via piston rod 78. When Θ 182 is greater than 45°, an amount of force required to be applied to gear plate 72 in direction 98 in order to move cylindrical gear head 74 in direction 96 is greater than an amount of force required to be applied to cylindrical gear head 74 in direction 92 via piston rod 78 in order to "hold" gear plate 72 in position (i.e., when concrete is being compressed in mold 46).

However, the more Θ 182 is increased above 45°, the less distance gear plate 72, and thus corresponding liner plate 32a, will move in direction 94 when

cylindrical gear head 74 is forced in direction 92. A preferred operational angle for Θ 182 is approximately 70°. This angle represents roughly a balance, or compromise, between the length of travel of gear plate 72 and an increase in the level of force required to be applied in direction 98 on gear plate 72 to force gear head 74 in direction 96. Gear plate 72 and cylindrical gear head 74 and their corresponding angled channels 176 and 206 reduce the required psi rating of cylinder 76 necessary to maintain the position of liner plate 32a when concrete is being compressed in mold cavity 46 and also reduces the wear experienced by cylinder 76. Additionally, from the above discussion, it is evident that one method for controlling the travel distance of liner plate 32a is to control the angle (Θ) 182 of the angled channels 176 and 206 respectively of gear plate 72 and cylindrical gear head 74.

Figure 6A is a top view 220 of gear track 80. Gear track 80 has a top surface 220, a first end surface 224, and a second end surface 226. A rectangular gear channel, indicated by dashed lines 228, having a first opening 230 and a second opening 232 extends through gear track 80. An arcuate channel 234, having a radius required to accommodate cylindrical gear head 76 extends across top surface 220 and forms a gear window 236 extending through top surface 222 into gear channel 228. Gear track 80 has a width 238 incrementally less than a width of gear opening 126 in side member 36a (see also Figure 3A).

Figure 6B is an end view 250 of gear track 80, as indicated by direction arrow 240 in Figure 6A, further illustrating gear channel 228 and arcuate channel 234. Gear track 80 has a depth 252 incrementally less than height of gear opening 126 in side member 36a (see Figure 3A). Figure 6B is a side view 260 of gear track 80 as indicated by directional arrow 242 in Figure 6A.

Figure 7 is a top view 270 illustrating the relationship between gear track 80 and gear plate 72. Gear plate 72 has a width 272 incrementally less than a width 274 of gear track 80, such that gear plate 72 can be slidably inserted into gear channel 228 via first opening 230. When gear plate 72 is inserted within gear track 80, angled channels 172 and linear teeth 176 are exposed via gear window 236.

Figure 8A is a top view 280 illustrating the relationship between gear plate 72, cylindrical gear head 74, and gear track 80. Gear plate 72 is indicated as being slidably inserted within guide track 80. Cylindrical gear head 74 is indicated as being positioned within arcuate channel 234, with the angled channels and linear teeth of cylindrical gear head 74 being slidably mated and interlocked with the angled channels 172 and linear teeth 176 of gear plate 72. When cylindrical gear head 74 is moved in direction 92 by extending piston rod 78, gear plate 72 extends outward from gear track 80 in direction 94 (See also Figure 9B below). When cylindrical gear head 74 is moved in direction 96 by retracting piston rod 78, gear plate 72 retracts into gear track 80 in direction 98 (See also Figure 9A below).

Figure 8B is a side view 290 of gear plate 72, cylindrical gear head 74, and guide track 80 as indicated by directional arrow 282 in Figure 8A. Cylindrical gear head 74 is positioned such that surface 202 is located within arcuate channel 234. Angled channels 204 and teeth 206 of cylindrical gear head 74 extend through gear window 236 and interlock with angled channels 172 and linear teeth 176 of gear plate 72 located within gear channel 228. Figure 8C is an end view 300 as indicated by directional arrow 284 in Figure 8A, and further illustrates the relationship between gear plate 72, cylindrical gear head 74, and guide track 80.

Figure 9A is top view 310 illustrating gear plate 72 being in a fully retracted position within gear track 80, with liner plate 32a being retracted against cross member 36a. For purposes of clarity, cylindrical gear head 74 is not shown. Angled channels 172 and linear teeth 176 are visible through gear window 236. Liner plate 32a is indicated as being coupled to gear plate 72 with a plurality of fasteners 128 extending through liner plate 32a into gear plate 72. In one embodiment, fasteners 128 threadably couple liner plate 32a to gear plate 72.

Figure 9B is a top view 320 illustrating gear plate 72 being extended, at least partially from gear track 80, with liner plate 32a being separated from cross member 36a. Again, cylindrical gear head 74 is not shown and angled channels 172 and linear teeth 176 are visible through gear window 236.

Figure 10A is a diagram 330 illustrating one exemplary embodiment of a gear drive assembly 332 according to the present invention. Gear drive assembly 332 includes cylindrical gear head 74, cylinder 76, piston rod 78, and a cylindrical sleeve 334. Cylindrical gear head 74 and piston rod 78 are configured to slidably insert into cylindrical sleeve 334. Cylinder 76 is threadably coupled to cylindrical sleeve 334 with an O-ring 336 making a seal. A window 338 along an axis of cylindrical sleeve 334 partially exposes angled channels 204 and linear teeth 206. A fitting 342, such as a pneumatic or hydraulic fitting, is indicated as being threadably coupled to aperture 82. Cylinder 76 further includes an aperture 344, which is accessible through cross member 36a.

Gear drive assembly 332 is configured to slidably insert into cylindrical gear shaft 134 (indicated by dashed lines) so that window 338 intersects with gear slot 126 so that angled channels 204 and linear teeth 206 are exposed within gear slot 126. Gear track 80 and gear plate 72 (not shown) are first slidably inserted into gear slot 126, such that when gear drive assembly 332 is slidably inserted into cylindrical gear shaft 134 the angled channels 204 and linear teeth 206 of cylindrical gear head 74 slidably mate and interlock with the angled channels 172 and linear teeth 176 of gear plate 72.

In one embodiment, a key 340 is coupled to cylindrical gear head 74 and rides in a key slot 342 in cylindrical sleeve 334. Key 340 prevents cylindrical gear head 74 from rotating within cylindrical sleeve 334. Key 340 and key slot 342 together also control the maximum extension and retraction of cylindrical gear head 74 within cylindrical sleeve 334. Thus, in one embodiment, key 340 can be adjusted to control the extension distance of liner plate 32a toward the interior of mold cavity 46. Figure 10A is a top view 350 of cylindrical shaft 334 as illustrated in Figure 10B, and further illustrates key 340 and key slot 342.

Figure 11A is a top view illustrating one exemplary embodiment of a mold assembly 360 according to the present invention for forming two concrete blocks. Mold assembly 360 includes a mold frame 361 having side members 34a and 34b and cross members 36a through 36c coupled to one another so as to form a pair of mold boxes 42a and 42b. Mold box 42a includes moveable liner

plates 32a through 32d and corresponding removable liner faces 33a through 33d configured to form a mold cavity 46a. Mold box 42b includes moveable liner plates 32e through 32h and corresponding removable liner faces 33e through 33h configured to form a mold cavity 46b.

Each moveable liner plate has an associated gear drive assembly located internally to an adjacent mold frame member as indicated by 50a through 50h. Each moveable liner plate is illustrated in an extended position with a corresponding gear plate indicated by 72a through 72h. As described below, moveable liner plates 32c and 32e share gear drive assembly 50c/e, with gear plate 72e having its corresponding plurality of angled channels facing upward and gear plate 72c having its corresponding plurality of angled channels facing downward.

Figure 11B is diagram illustrating a gear drive assembly according to the present invention, such as gear drive assembly 50c/e. Figure 11B illustrates a view of gear drive assembly 50c/e as viewed from section A-A through cross-member 36c of Figure 11A. Gear drive assembly 50c/e includes a single cylindrical gear head 76c/e having angled channels 204c and 204e on opposing surfaces. Cylindrical gear head 76c/e fits into arcuate channels 234c and 234e of gear tracks 80c and 80d, such that angled channels 204c and 204e slidably interlock with angled channels 172c and 172e of gear plates 72c and 72e respectively.

Angled channels 172c and 204c, and 172e and 204e oppose one another and are configured such that when cylindrical gear head 76c/e is extended (e.g. out from Figure 11B) gear plate 72c moves in a direction 372 toward the interior of mold cavity 46a and gear plate 72e moves in a direction 374 toward the interior of mold cavity 46b. Similarly, when cylindrical gear head 76c/e is retracted (e.g. into Figure 11B) gear plate 72c moves in a direction 376 away from the interior of mold cavity 46a and gear plate 72e moves in a direction 378 away from the interior of mold cavity 378. Again, cylindrical gear head 76c/e and gear plates 72c and 72c could be of any suitable shape.

Figure 12 is a perspective view illustrating a portion of one exemplary embodiment of a mold assembly 430 according to the present invention. Mold

assembly includes moveable liner plates 432a through 432l for simultaneously molding multiple concrete blocks. Mold assembly 430 includes a drive system assembly 431 having a side members 434a and 434b, and cross members 436a and 436b. For illustrative purposes, side member 434a is indicated by dashed lines. Mold assembly 430 further includes division plates 437a through 437g.

Together, moveable liner plates 432a through 432l and division plates 437a through 437g form mold cavities 446a through 446f, with each mold cavity configured to form a concrete block. Thus, in the illustrated embodiment, mold assembly 430 is configured to simultaneously form six blocks. However, it should be apparent from the illustration that mold assembly 430 can be easily modified for simultaneously forming quantities of concrete blocks other than six.

In the illustrated embodiment, side members 434a and 434b each have a corresponding gear drive assembly for moving moveable liner plates 432a through 432f and 432g through 432l, respectively. For illustrative purposes, only gear drive assembly 450 associated with side member 434a and corresponding moveable liner plates 432a through 432g is shown. Gear drive assembly 450 includes first gear elements 472a through 472f selectively coupled to corresponding moveable liner plates 432a through 432f, respectively, and a second gear element 474. In the illustrated embodiment, first gear elements 472a through 472f and second gear element 474 are shown as being cylindrical in shape. However, any suitable shape can be employed.

Second gear element 474 is selectively coupled to a cylinder-piston (not shown) via a piston rod 478. In one embodiment, which is described in greater detail below (see Figure 12), second gear element 474 is integral with the cylinder-piston so as to form a single component.

In the illustrated embodiment, each first gear element 472a through 472b further includes a plurality of substantially parallel angled channels 484 that slidably mesh and interlock with a plurality of substantially parallel angled channels 486 on second gear element 474. When second gear element 474 is moved in a direction indicated by arrow 492, each of the moveable liner plates 432a through 432f moves in a direction indicated by arrow 494. Similarly, when second gear element 474 is move in a direction indicated by arrow 496, each of

the moveable liner plates 432a through 432f moves in a direction indicated by arrow 498.

In the illustrated embodiment, the angled channels 484 on each of the first gear elements 432a through 432f and the angled channels 486 are at a same angle. Thus, when second gear element 474 moves in direction 492 and 496, each moveable liner plate 432a through 432f moves a same distance in direction 494 and 498, respectively. In one embodiment, second gear element 474 includes a plurality of groups of substantially parallel angled channels with each group corresponding to a different one of the first gear elements 472a through 472f. In one embodiment, the angled channels of each group and its corresponding first gear element have a different angle such that each moveable liner plate 432a through 432f move a different distance in directions 494 and 498 in response to second gear element 474 being moved in direction 492 and 496, respectively.

Figure 13 is a perspective view illustrating a gear drive assembly 500 according to the present invention, and a corresponding moveable liner plate 502 and removable liner face 504. For illustrative purposes, a frame assembly including side members and cross members is not shown. Gear drive assembly 500 includes double rod-end, dual-acting pneumatic cylinder-piston 506 having a cylinder body 507, and a hollow piston rod 508 with a first rod-end 510 and a second rod-end 512. Gear drive assembly 500 further includes a pair of first gear elements 514a and 514b selectively coupled to moveable liner plate 502, with each first gear element 514a and 514b having a plurality of substantially parallel angled channels 516a and 516b.

In the illustrated embodiment, cylinder body 507 of cylinder-piston 506 includes a plurality of substantially parallel angled channels 518 configured to mesh and slidably interlock with angled channels 516a and 516b. In one embodiment, cylinder body 507 is configured to slidably insert into and couple to a cylinder sleeve having angled channels 518.

In one embodiment, cylinder-piston 506 and piston rod 508 are located within a drive shaft of a frame member, such as drive shaft 134 of cross-member 36a, with rod-end 510 coupled to and extending through a frame member, such

as side member 34b, and second rod-end 512 coupled to and extending through a frame member, such a side member 34a. First rod-end 510 and second rod-end 512 are configured to receive and provide compressed air to drive dual-acting cylinder-piston 506. With piston rod 508 being fixed to side members 34a and 34b via first and second rod-ends 512 and 510, cylinder-piston 506 travels along the axis of piston rod 508 in the directions as indicated by arrows 520 and 522 in response to compressed air received via first and second rod-ends 510 and 512.

When compressed air is received via second rod-end 512 and expelled via first rod-end 510, cylinder-piston 506 moves within a drive shaft, such as drive shaft 134, in direction 522 and causes first gear elements 514a and 516b and corresponding liner plate 502 and liner face 504 to move in a direction indicated by arrow 524. Conversely, when compressed air is received via first rod-end 510 and expelled via second rod-end 512, cylinder-piston 506 moves within a gear shaft, such as gear shaft 134, in direction 520 and causes first gear elements 514a and 516b and corresponding liner plate 502 and liner face 504 to move in a direction indicated by arrow 526.

In the illustrated embodiment, cylinder-piston 506 and first gear elements 514a and 514b are shown as being substantially cylindrical in shape. However, any suitable shape can be employed. Furthermore, in the illustrated embodiment, cylinder-piston 506 is a double rod-end dual-acting cylinder. In one embodiment, cylinder piston 506 is a single rod-end dual acting cylinder having only a single rod-end 510 coupled to a frame member, such as side member 34b. In such an embodiment, compressed air is provided to cylinder-piston via single rod-end 510 and a flexible pneumatic connection made to cylinder-piston 506 through side member 34a via gear shaft 134. Additionally, cylinder-piston 506 comprises a hydraulic cylinder.

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is

intended that this invention be limited only by the claims and the equivalents thereof.